Mechanism Feasibility Design Task

Dr. James Gopsill

Contents

Teaching Aims

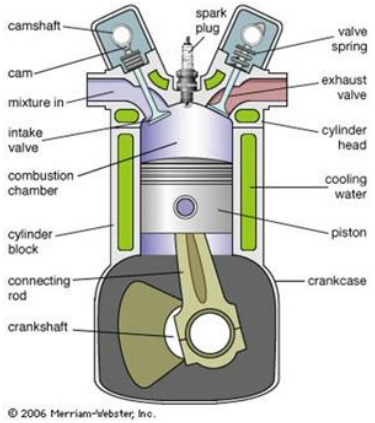
1. Provide awareness of mechanisms and their applications
2. Further practice design thinking, rationale capture and build on the feedback from the previous coursework
3. Apply system modelling tools to preliminary design scenarios
4. To generate a feasible mechanism design for the design task
5. Practice your theoretical engineering knowledge in an unconstrained and unfamiliar environment

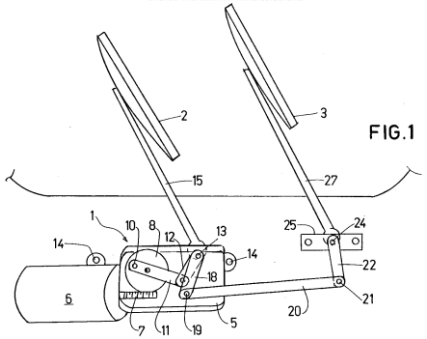
Multi-Bar Mechanisms are often used to:

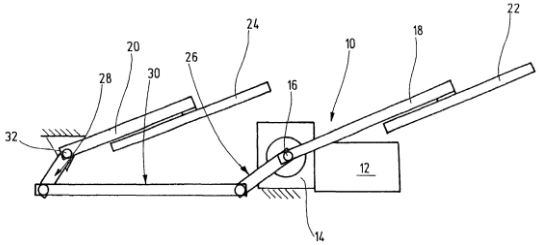
- Translate motions & forces
- Improve the performance of a product
- Simplify the control system of a product
- Increase the efficiency of a product
- Deploy a product

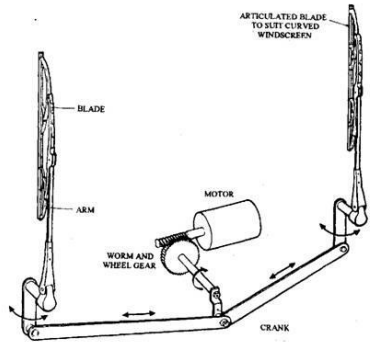
Translation of Motion & Force

- Piston
- Window Hinge
- Windscreen Wipers
- Locking Pliers/Vice Grips
- Provide a Mechanical Advantage



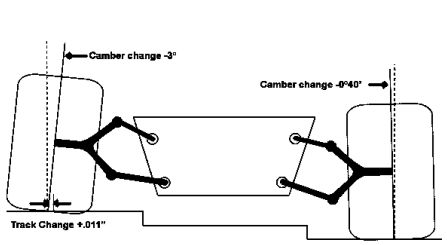


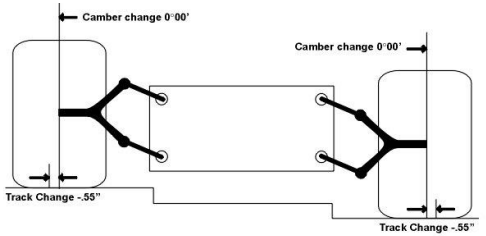


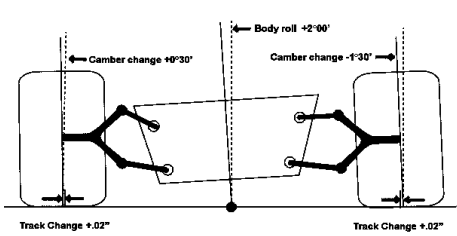


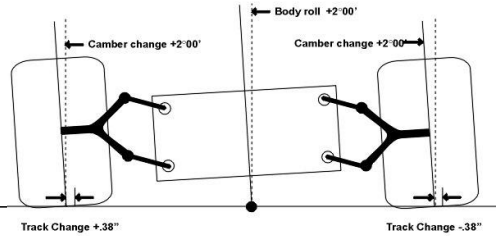
Improving the Performance of a Product

- Widely used in suspension design
- Double wishbone
- Enables camber control as a car rolls (positive camber gain)









Unequal length, non-parallel link double wishbones

Equal length, parallel link double wishbones

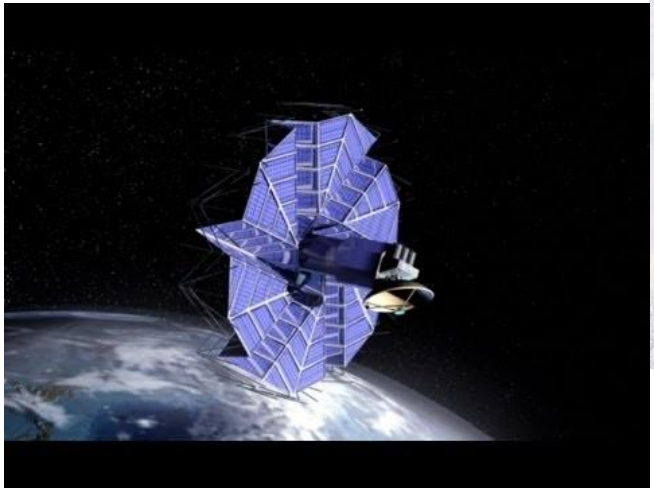
Simplify the Control System of a Product

- Level-luffing cranes
- Maintain a steady platform

https://www.youtube.com/watch?v=Qhis3_I2_-0

Deploying a Product

- Scissor Jacks
- Convertible Roofs
- Satellite Solar Panels

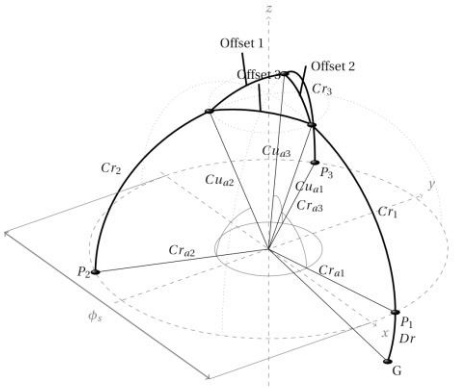


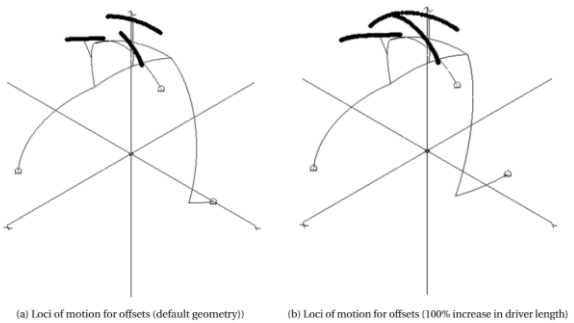
And Art!

https://www.youtube.com/watch?v=PG2Xv2ivZZU

Research at Bristol

- Modelling chewing
- Develop Capsules for Drug Delivery
- Spherical mechanisms





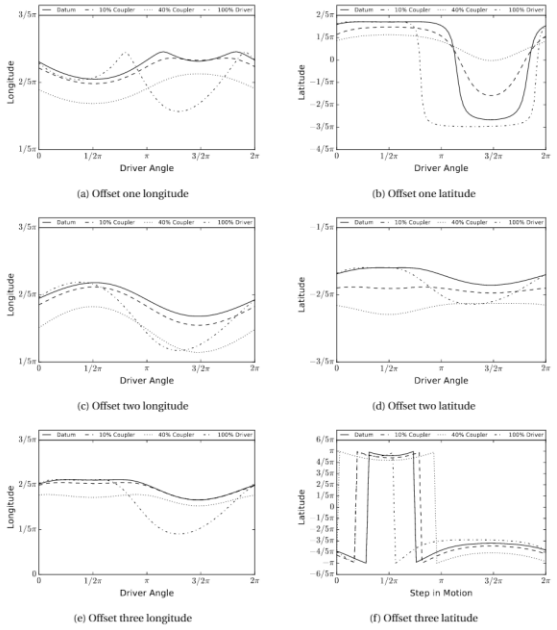
(a) Loci of motion for offsets (default geometry))

(b) Loci of motion for offsets (100% increase in driver length)

(c) Loci of motion for offsets (10% increase in coupler lengths)

(d) Loci of motion for offsets (40% increase in coupler lengths))

Figure 5: Loci of motion with varying offsets



(a) Offset one longitude

(b) Offset one latitude

(c) Offset two longitude

(d) Offset two latitude

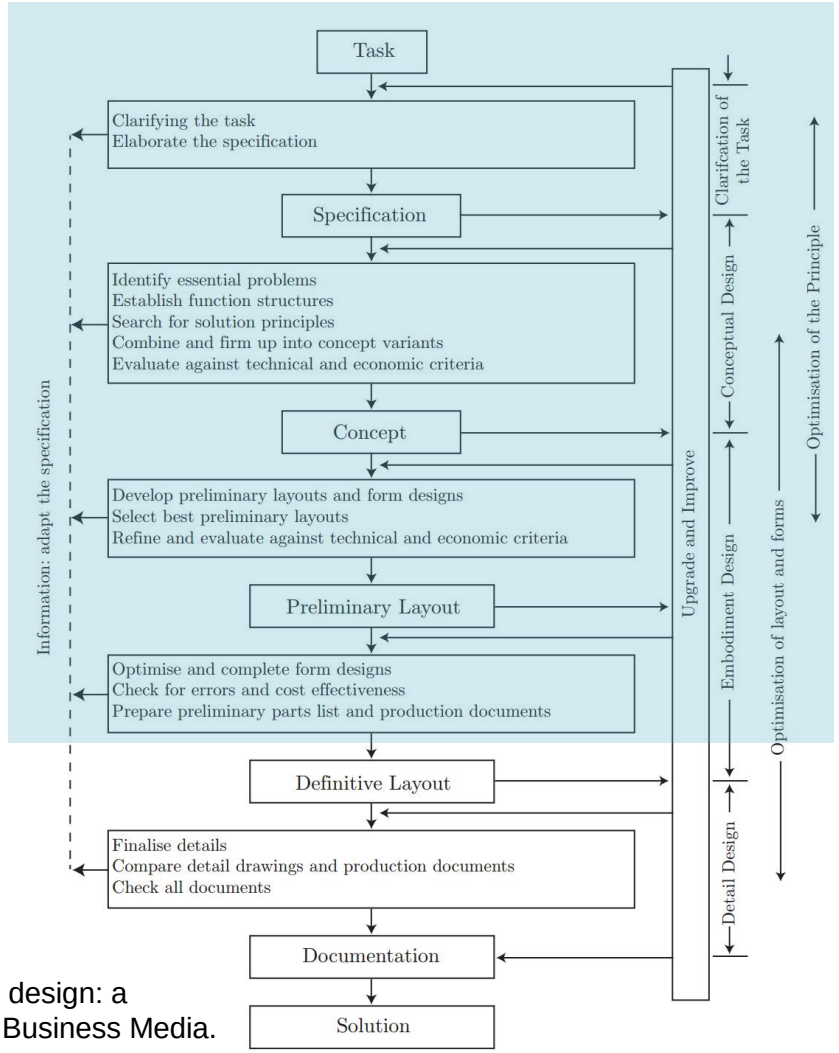
(e) Offset three longitude

(f) Offset three latitude

Figure 7: Longitude and latitude offset path comparison

Feasibility Design

1. Develop your specification
2. Generate concepts
3. Concept selection
4. Preliminary layout & design

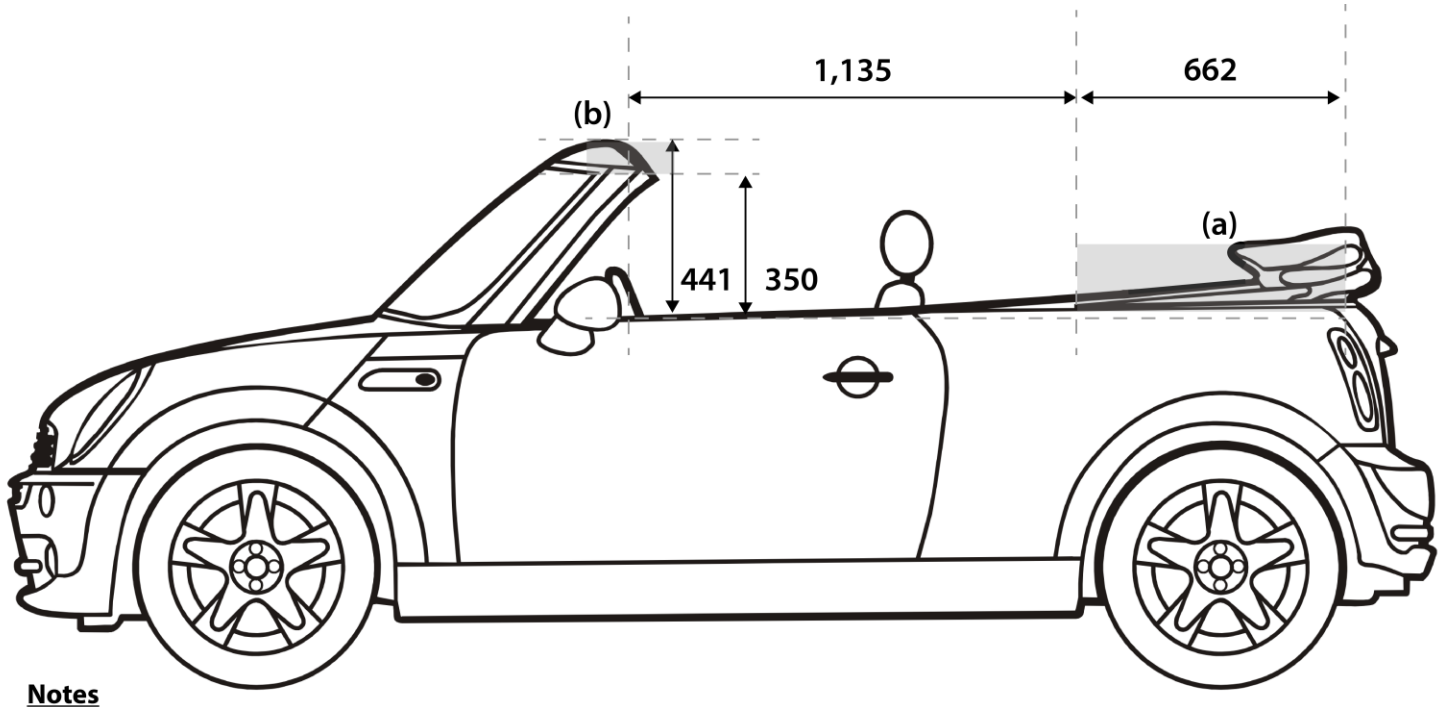


Pahl, G. and Beitz, W., 2013. Engineering design: a systematic approach. Springer Science & Business Media.

Exercise

To design a mechanism to deploy and retract a car convertible roof

Exercise



Notes
All dimensions in mm
(a) - Ideal position where the deployment mechanism can be connected to the vehicle
(b) - Windscreen connection point

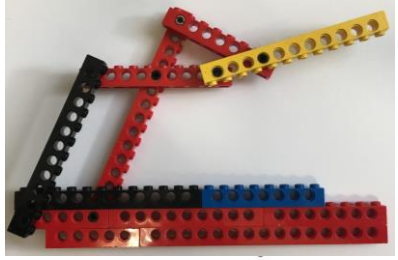
Design Process

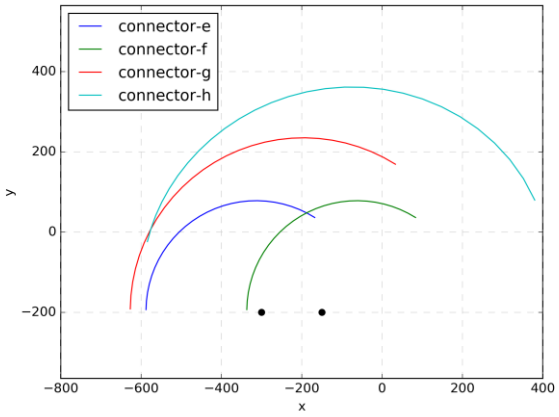
Product Design Specification

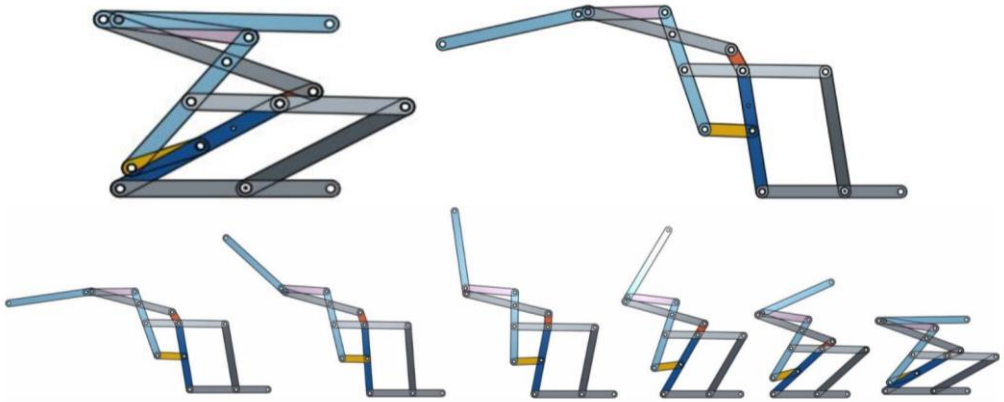
No.	Requirement	Must/Wish	Method of Assessment	Success Criteria	Will be assessed during the feasibility stage
1					
2					
3					
…					

Design Process

- Product Design Specification
- Concept Design







Design Process

- Product Design Specification
- Concept Design
- Concept Selection

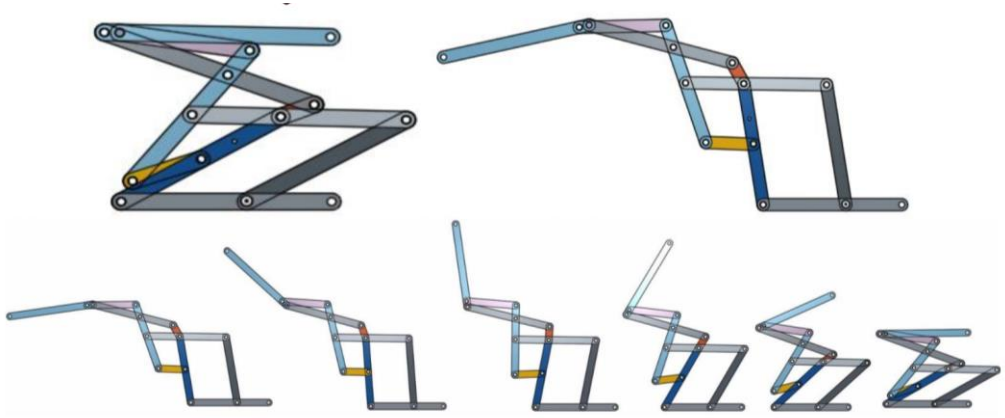
Criteria	Concept 1	Concept 2	Concept 3	Concept 4	Concept 5	Concept 6
Ease of use	DATUM	+	+	-	-	S
Aesthetic appeal		-	+	+	-	-
Manufacturability		+	+	-	+	+
Low weight		+	-	+	-	+
Energy efficiency		S	+	-	+	+
Safety		-	+	S	-	+
Σ+		3	5	2	2	4
Σ-		2	1	3	4	1
ΣS		1	0	1	0	1
Net Score	0	1	4	-1	-2	3
Rank	4	3	1	5	6	2
Continue or combine?	Combine	Combine	Yes	No	No	Yes

Controlled Convergence
Andy Greener 1st Year Notes

Design Process

- Product Design Specification
- Concept Design
- Concept Selection
- Stage-Gate

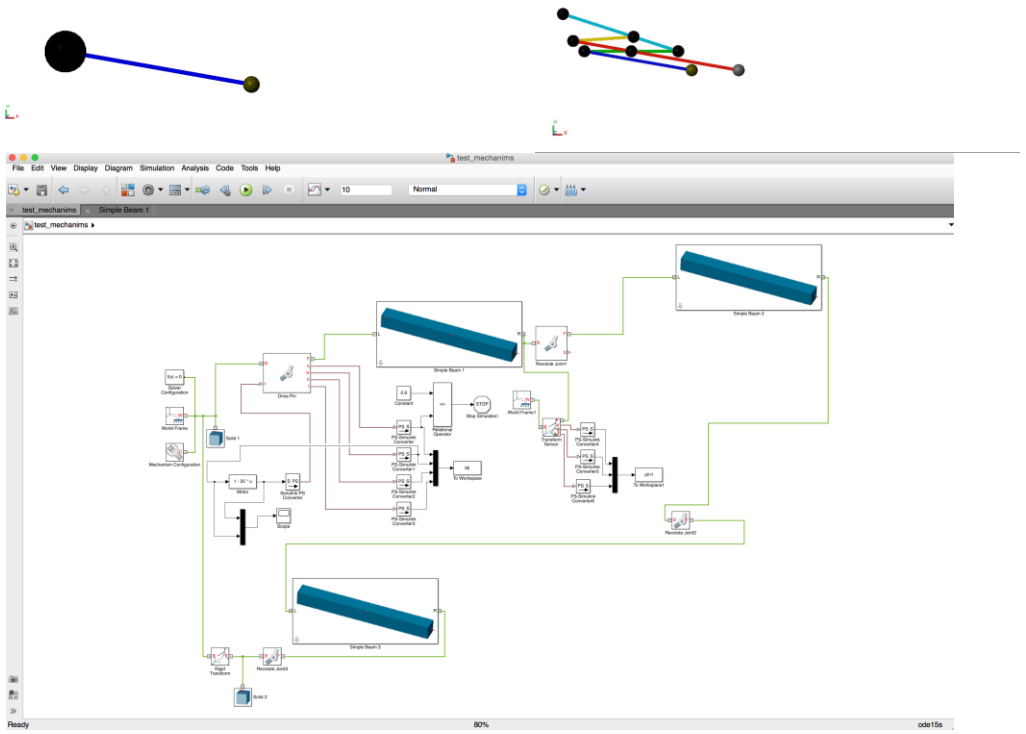
No.	Requirement	Must/Wish	Method of Assessment	Success Criteria	Will be assessed during the feasibility stage
1					
2					



Product Design Specification &
Linkage Concept Design
Submission (5%, pass/fail)

Design Process

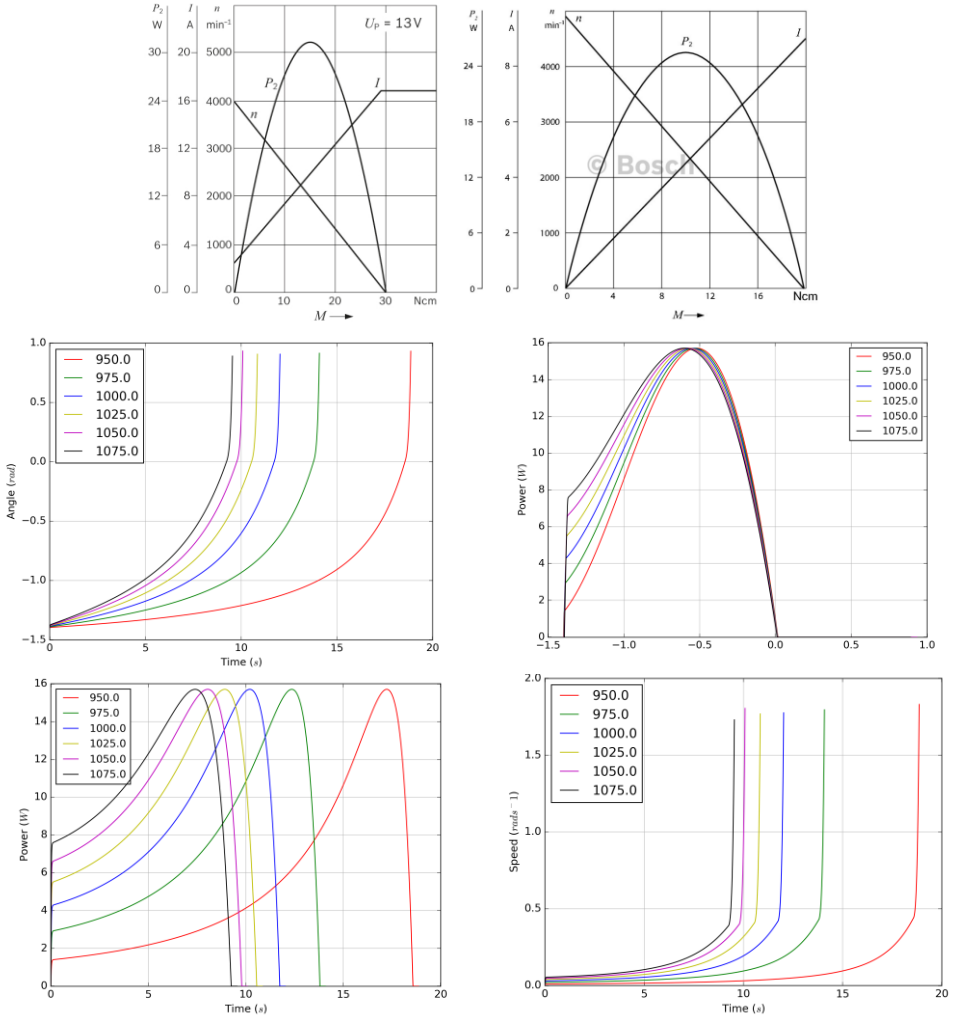
- Product Design Specification
- Concept Design
- Concept Selection
- Stage-Gate
- Deployment Modelling



1st Year & A-Level Engineering Maths
Equations of Motion, Torque, Gravity, Gear Ratios & Motor Power

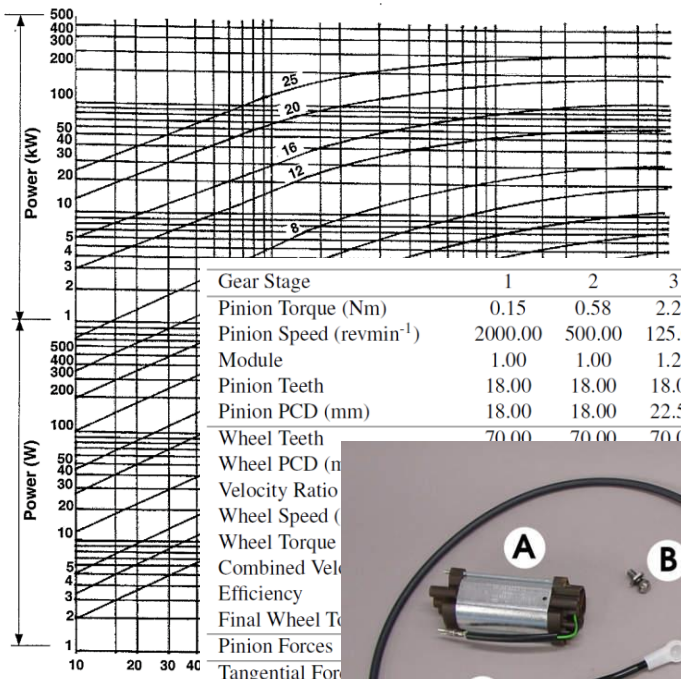
Design Process

- Product Design Specification
- Concept Design
- Concept Selection
- Stage-Gate
- Deployment Modelling
- Motor, Gear Ratio & Damping Selection



Design Process

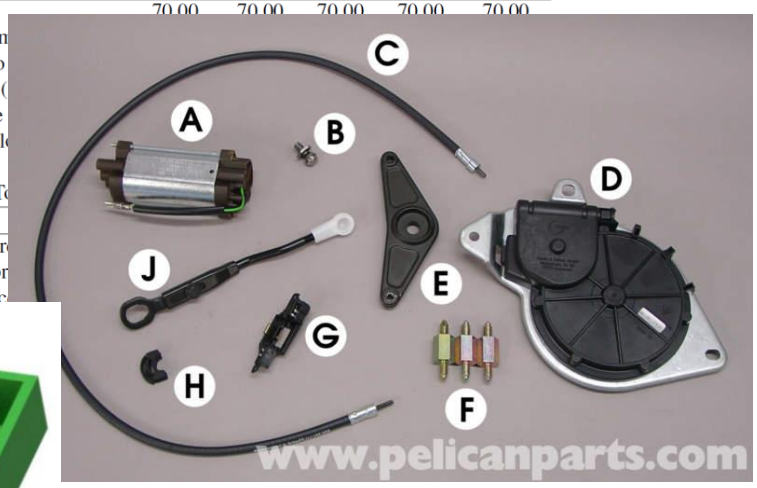
- Product Design Specification
- Concept Design
- Concept Selection
- Stage-Gate
- Deployment Modelling
- Motor, Gear Ratio & Damping Selection
- Gearbox Design

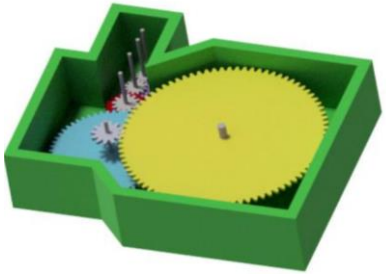


$$F_s = F_t \tan \alpha$$

$$F_t = \frac{2T}{d}$$

Gear Stage	1	2	3	4	5
Pinion Torque (Nm)	0.15	0.58	2.21	8.49	32.61
Pinion Speed (revmin^{-1})	2000.00	500.00	125.00	31.25	7.81
Module	1.00	1.00	1.25	2.00	2.50
Pinion Teeth	18.00	18.00	18.00	18.00	18.00
Pinion PCD (mm)	18.00	18.00	22.50	36.00	45.00
Wheel Teeth	70.00	70.00	70.00	70.00	70.00
Wheel PCD (n					
Velocity Ratio					
Wheel Speed (					
Wheel Torque					
Combined Vel					
Efficiency					
Final Wheel T					
Pinion Forces					
Tangential For					
Separating For					
Resultant Forc					





Design Process

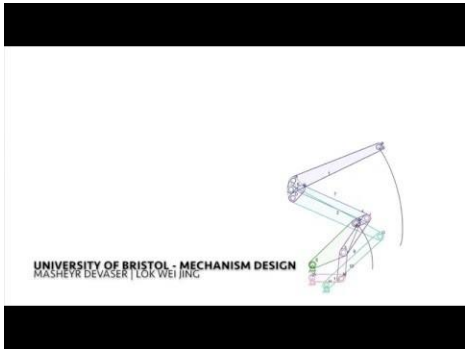
- Product Design Specification
- Concept Design
- Concept Selection
- Stage-Gate
- Deployment Modelling
- Motor, Gear Ratio & Damping Selection
- Gearbox Design
- Submission

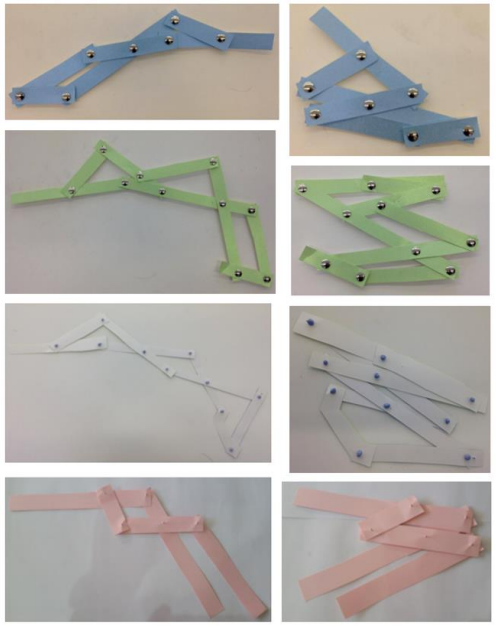
- Stage-gate submission (5%, pass/fail)
- Design Report (LaTeX Template provided)
  - Title page
  - Introduction (1 page)
  - Product Design Specification (1 page, 10%)
  - Concept Design & Selection (2 pages, 10%)
  - Deployment Modelling (3 pages, 15%)
  - Motor, Gear Ratio & Damping Selection (3 pages, 15%)
  - Gearbox Design (3 pages, 15%)
  - Solution Specification (1 page)
  - Conclusion & References (1 page)
- A3 Print Out of Simulink Model (10%)
- A3 Assembly Drawing of the Gearbox (10%)

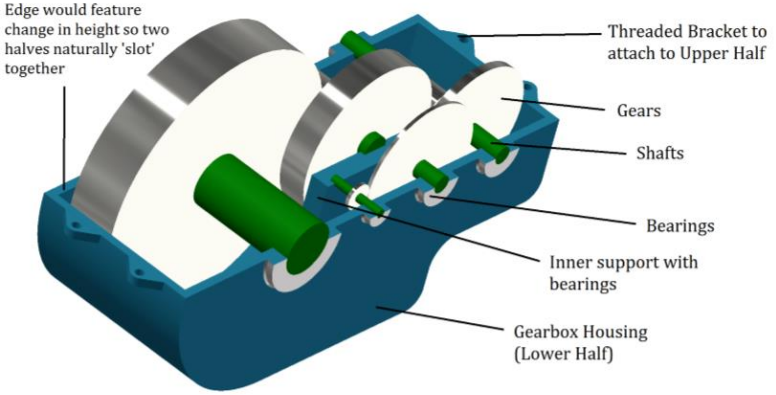
Additional Notes:

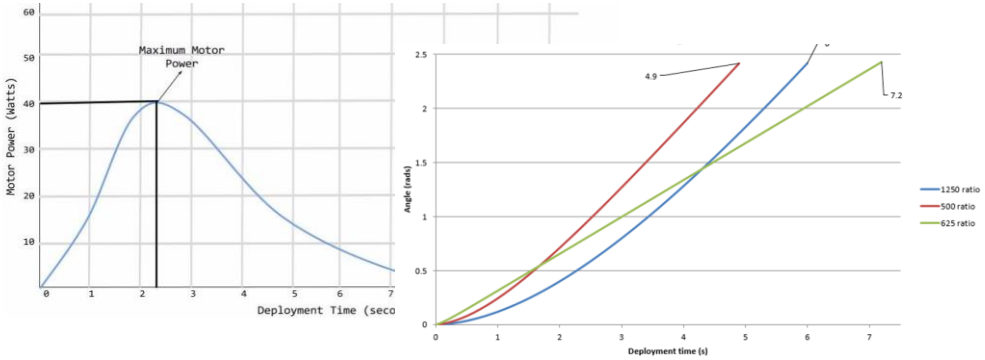
- 10% of the mark is awarded to the quality of the report writing
- The reference list may go beyond the 15 page limit

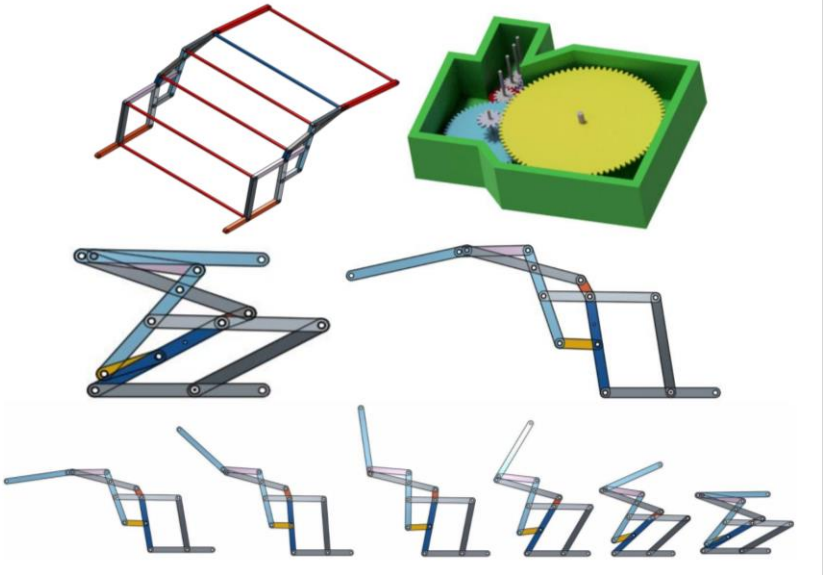
Previous Years











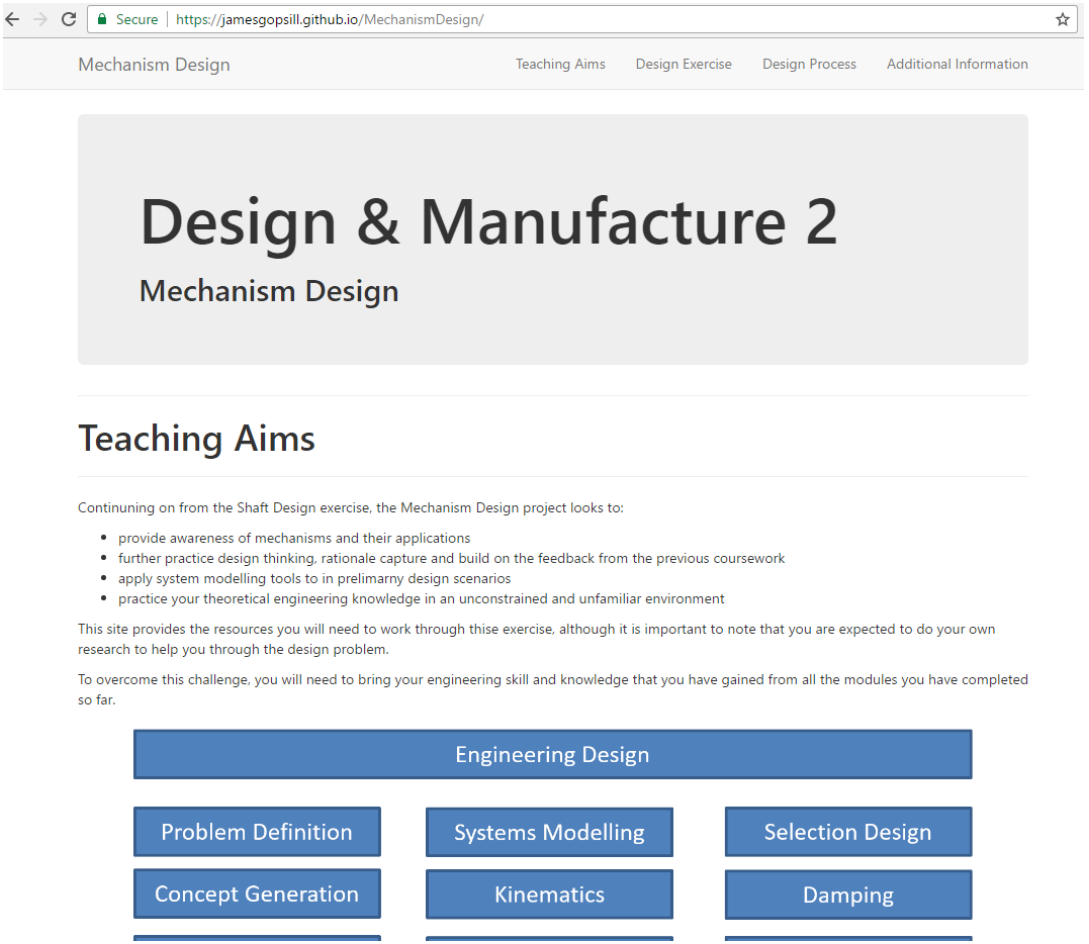
https://www.youtube.com/watch?v=5yb7UNZG4nk

Timeline

Academic Week	Date	Time	Type	Content
13	Monday 23rd January 2017	15:00-16:00	Lecture	Introduction to the Overall Course & Constrained Design Task Introduction
13	Tuesday 24th January 2017	9:00-13:00	Tutorial	Form groups, Exercise Familiarisation & Product Design Requirements
13	Tuesday 24th January 2017	14:00-15:00	Lecture	Reactions, Bending and Macaulay Notation
14	Tuesday 31st January 2017	9:00-13:00	Tutorial	Reactions and Bending Moments
14	Tuesday 31st January 2017	14:00-15:00	Lecture	Bearing Selection
15	Tuesday 7th February 2017	9:00-13:00	Tutorial	Bearing Selection
15	Tuesday 7th February 2017	14:00-15:00	Lecture	Sprocket and Safety Factors
15	**Friday 10th February 2017**		**Submission**	**Shear Force & Bending Moment Diagrams (Blackboard)**
16	Tuesday 14th February 2017	9:00-13:00	Tutorial	Sprocket and Chain Selection
16	Tuesday 14th February 2017	14:00-15:00	Lecture	Fixings and Submission Details
17	Tuesday 21st February 2017	9:00-13:00	Tutorial	Fixings
17	Tuesday 21st February 2017	14:00-15:00	Lecture	Introduction to the Feasibility Design Task
18	**Reading Week**			
19	**Monday 6th March 2017**		**Submission**	**Constrained Design Report Submission (Office and Blackboard)**
19	Tuesday 7th March 2017	9:00-13:00	Tutorial	Form pairs, Exercise Familiarisation & Product Design Specification
19	Tuesday 7th March 2017	14:00-15:00	Lecture	Product Design Specification, Concept Design & Selection
20	Tuesday 14th March 2017	9:00-13:00	Tutorial	Concept Design & Selection
20	Tuesday 14th March 2017	14:00-15:00	Lecture	Modelling the Deployment of the Mechanism 1
20	**Friday 17th March 2017**		**Submission**	**PDS & Linkage Model of Selected Concept (Blackboard)**
21	Tuesday 21st March 2017	9:00-13:00	Tutorial	Deployment Modelling
21	Tuesday 21st March 2017	14:00-15:00	Lecture	Modelling the Deployment of the Mechanism 2
22	Tuesday 28th March 2017	9:00-13:00	Tutorial	Deployment Modelling and Motor & Gear Ratio Selection
22	Tuesday 28th March 2017	14:00-15:00	Lecture	Gearbox Design
	Easter			
23	Tuesday 25th April 2017	9:00-13:00	Tutorial	Gearbox Design
23	Tuesday 25th April 2017	14:00-15:00	Lecture	General Assemblies & Submission Details
24	Tuesday 2nd May 2017	9:00-13:00	Tutorial	Report Writing and Submission
24	Tuesday 2nd May 2017	14:00-15:00	Lecture	Free
24	**Friday 5th May 2017**	**14:00-15:00**	**Submission**	**Feasibility Design Report Submission**

Resources

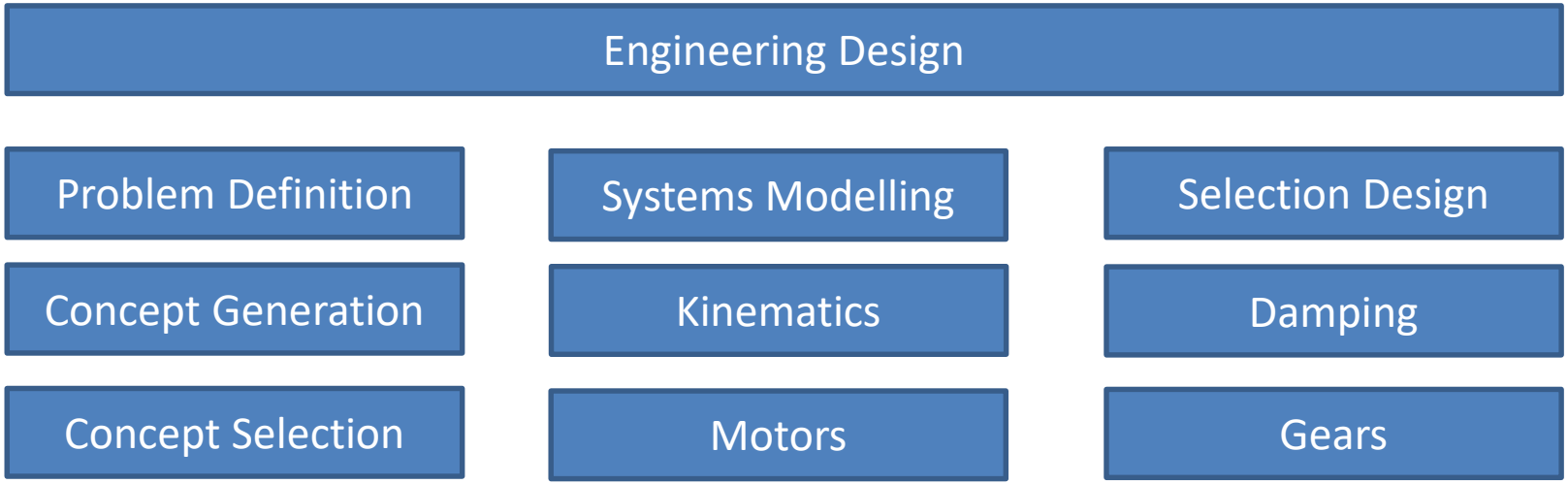
- https://jamesgopsill.github.io/MechanismDesign/
- YouTube Demos for Simulink
- All New This Year!



Feedback

- 6 x 4 Hour Tutorial Sessions
- 8 Academic Staff Available to Answer Questions
- Shaft Design Report
- Stage-Gate
- Mechanism Design Report

Engineering Knowledge & Skills



After Reading Week

- Pair Up!
- Familiarise yourself with the exercise
- Initial research to build your Product Design Specification

Q & A